NASA/JOHN C. STENNIS SPACE CENTER

SURVEILLANCE PLAN

PERFORMANCE-BASED CONTRACT NAS13-98048

with

SPACE IMAGING EOSAT

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PURPOSE

This surveillance plan defines the process the Government expects to follow to obtain data, evaluate the contractor, and determine if contract performance is acceptable. The Government reserves the right to modify this plan at any time during the contract.

NASA issued this firm-fixed-price indefinite delivery indefinite quantity (IDIQ) contract as the second phase of a Congressionally mandated demonstration program to purchase NASA Earth Science Enterprise (ESE)-related scientific data products from the private sector. In the first phase, NASA issued a request for proposal to purchase prototype commercial remotely sensed data sets. After a technical and scientific assessment of these data sets, NASA issued IDIQ contracts to purchase products that passed this assessment. Purchasing commercial remotely sensed data for scientific use is a relatively new concept. Until recently, scientists controlled virtually all aspects of a remote sensing system, which gave their data the traceability needed to stand up to rigorous peer review of their research (Figure 1). With the introduction of cost-effective commercial remote sensing systems, scientists have more options for acquiring the data they need at a lower cost, but lose visibility into much of the data collection process. To make this trade acceptable to the science community, NASA must establish this traceability for scientific data products purchased from commercial sources. Commercial remotely sensed data delivered to the science community must also be free of obvious defects (unreadable media, missing pixels, incorrect geographic locations and collection times, etc.) to further ensure its acceptance as a valid source of data for research. Therefore, to achieve the goals of the Science Data Purchase (SDP) demonstration program, this contract must have a surveillance process with exceptional depth and breadth.

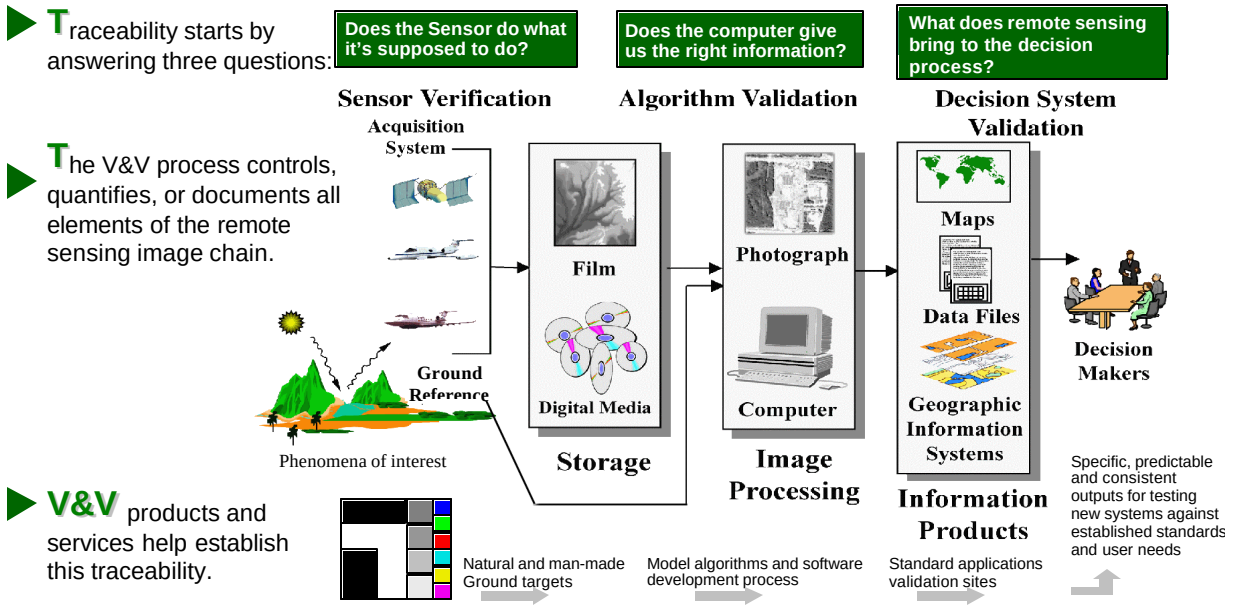

Figure 1. Verification and Validation of Remotely Sensed Imagery: Establishing traceability from the information products to what is actually happening on the ground.

PRODUCT DESCRIPTION

This contract procures imagery from the IKONOS satellite, the world's first high-resolution imaging satellite, for use by scientists affiliated with NASA Earth Science Enterprise. A delivery order establishes the initial group of images to be purchased. Tasking requests, which supplement the delivery order, specify imagery to be collected over specific locations at specific times and the type of product to be delivered. IKONOS provides panchromatic imagery with a 1-meter picture element (pixel) size. A nominal IKONOS scene is 11 kilometers by 11 kilometers, though the minimum order per image is 5 km by 5 km or 25 square kilometers. IKONOS also has a multi-spectral imager, which produces blue, green, red, and near-infrared images of the same ground area as the panchromatic, except that the ground resolution cell is four times larger. The images are then referenced to the correct Earth coordinates to specified levels at geometric accuracy (for example, Standard Original is+/-250 meters, while Precision Master is +/-2 meters). The Model products (Digital Elevation Model and Stereo Pair) use images of the same ground area taken from slightly different angles to create a three-dimensional representations of the Earth's surface in that area. The products offered by the Contractor include:

1A IKONOS Original (1-meter resolution panchromatic; 4-meter resolution multispectral)
1AA North America (Precision Corrected)
1AB North America (Standard Corrected)
1AC International (Precision Corrected)
1AD International (Standard Corrected)

1B IKONOS Master (1-meter resolution panchromatic; 4-meter resolution multispectral)
1BA North America (Precision Corrected)
1BB North America (Standard Corrected)
1BC International (Precision Corrected)
1BD International (Standard Corrected)

1C IKONOS Model (Digital Elevation Model and Stereo Pair)

SURVEILLANCE STRATEGY AND APPROACH

The data product line specified by this contract is the first of its kind available commercially, and scientific use of commercial remotely sensed data is relatively new. Accordingly, this surveillance plan attempts to perform as much inspection and test as possible, within the constraints of technology readiness, cost, surveillance resources, confidentiality, and importance of product characteristics to the end user. The actual surveillance process is a multi-tiered balance between these competing factors (Figure 2). All surveillance activities occur at NASA John C. Stennis Space Center (SSC).

FORMS OF SURVEILLANCE

This contract surveillance will take the following three primary forms:

Communications with the Contractor

- Teleconferences
- Informal discussions
- Electronic mail
- Surveillance team meetings
- Technical interchange meetings
- Tasking request letters

Independent Product Verification at NASA Stennis Space Center

- System Calibration and Documentation Review
- Product Validation – Random Sample
- Shipment Verification – 100% Inspection

Documentation and Reporting

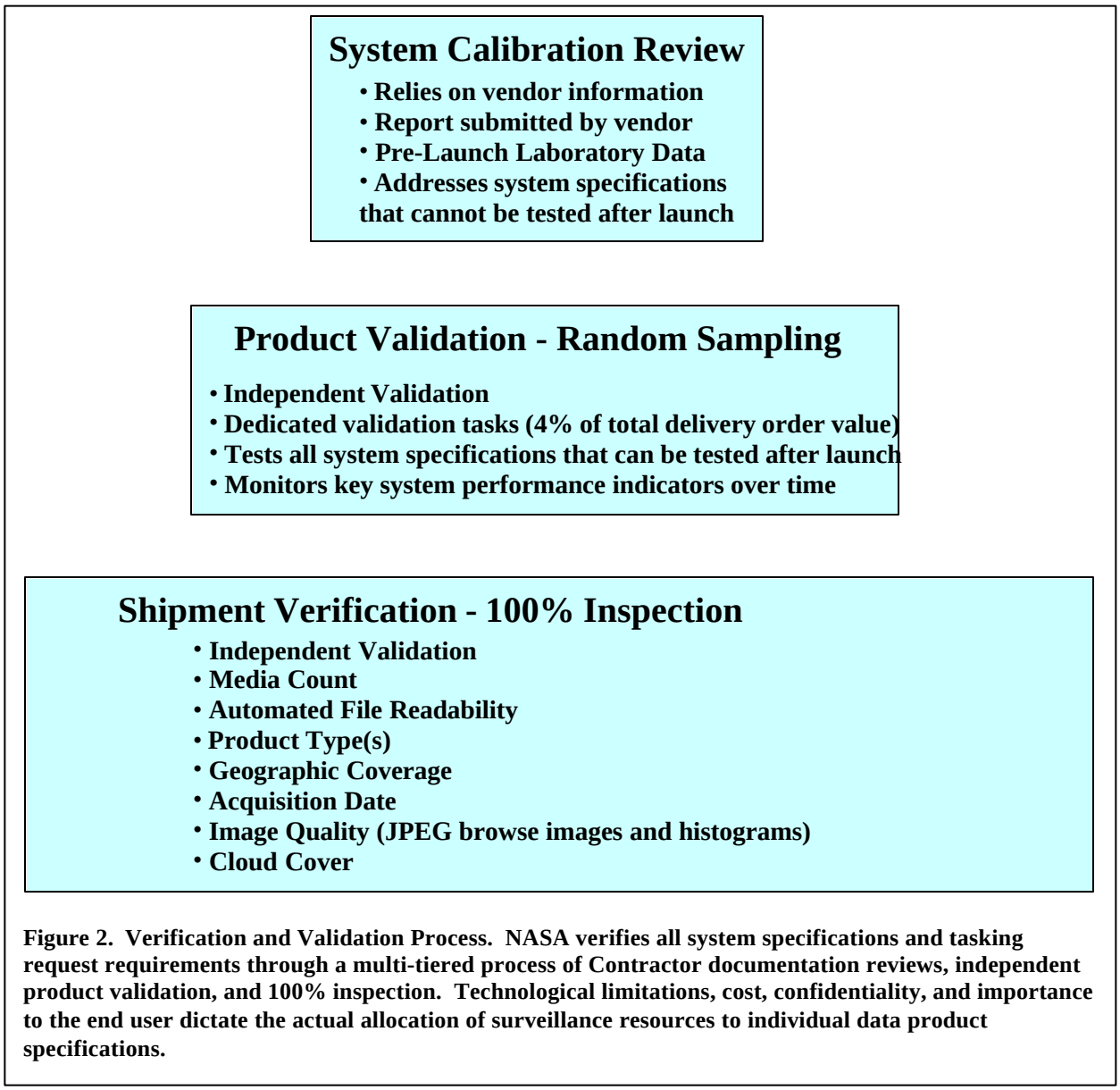

Figure 2. Verification and Validation Process. NASA verifies all system specifications and tasking request requirements through a multi-tiered process of Contractor documentation reviews, independent product validation, and 100% inspection. Technological limitations, cost, confidentiality, and importance to the end user dictate the actual allocation of surveillance resources to individual data product specifications.

SYSTEM CALIBRATION REVIEW

Some of the contract specifications require rigorous laboratory tests that cannot be performed in space. The contract requires the Contractor to submit laboratory calibration data to provide evidence that the satellite-based sensor system will meet those contract specifications that cannot be tested after launch. Table 1 lists the applicable contract specifications addressed during review of the system calibration reports.

Band edge point error at 50% peak response
Slope through the 50% point (%/micron)
Out of band filter response (% of total integrated transmittance within 5% transmission points of that band)
The response for 70% of the data centered on the peak. (% of maximum value).
Panchromatic MTF at Nyquist frequency
Multispectral MTF at Nyquist frequency
Panchromatic Ground Sampling Distance Multispectral Ground Sampling Distance
SNR at Nyquist frequency (Based on: 10% target reflectance 2:1 target-to-background ratio, 30 deg solar elevation)
SNR at zero spatial frequency
Absolute radiometric accuracy over the entire imaging exposure dynamic range (temporal stability)
Relative radiometric accuracy (pixel to pixel)
% of detectors within 5% of the mean quantum efficiency and dark current
% inoperable detectors prior to launch and % after 5 years MMD. Number of adjacent detectors inoperable.
Linearity over the entire imaging exposure dynamic range
Dynamic range (number of bits)

Table 1. Specifications addressed during system calibration review

PRODUCT VALIDATION – RANDOM SAMPLING

Once the satellite is operational, it is possible to test the data products against some of the contract specifications. Approximately four percent (4%) of the total delivery order contract value is dedicated to validation tasks. Table 2 lists the applicable contract specifications and the system validation activities designed to test the sample data products against them.

Panchromatic MTF at Nyquist frequency	Analyze images over edge targets to obtain MTF Validate prior to data purchase, every 2 months for the first year and every 4 months for the remainder of the data buy
Multispectral MTF at Nyquist frequency	Analyze images over edge targets to obtain MTF Validate prior to data purchase, every 2 months for the first year and every 4 months for the remainder of the data buy
Panchromatic Ground Sampling Distance Multispectral Ground Sampling Distance	Analyze images over edge targets to obtain GSD Validate prior to data purchase
SNR at Nyquist frequency (Based on: 10% target reflectance 2:1 target-to-background ratio, 30 deg solar elevation)	Analyze images over edge targets to obtain SNR Review on-board calibrations provided by SI Validate prior to data purchase, every 2 months for the first yr, and every 4 months for the remainder of the data buy
SNR at zero spatial frequency	Analyze images over edge targets to obtain SNR Review on-board calibrations provided by SI Validate prior to data purchase, every 2 months for the first yr, and every 4 months for the remainder of the data buy
Absolute radiometric accuracy over the entire imaging exposure dynamic range (temporal stability)	Review on-board calibrations provided by SI Analyze images over radiometric targets to obtain accuracy Validate prior to data purchase, every 2 months for first year, and every 4 months for the remainder of the data buy
Relative radiometric accuracy (pixel to pixel)	Review on-board calibrations provided by SI Analyze images over radiometric targets to obtain accuracy Validate prior to data purchase, every 2 months for first year, and every 4 months for the remainder of the data buy
% of detectors within 5% of the mean quantum efficiency and dark current	Review on-board calibrations provided by SI Analyze images over radiometric targets to obtain accuracy Validate prior to data purchase, every 2 months for first year, and every 4 months for the remainder of the data buy
% inoperable detectors prior to launch and % after 5 years MMD. Number of adjacent detectors inoperable.	Perform general statistical analysis of data Validate prior to data purchase, every 2 months for first year, and every 4 months for the remainder of the data buy
Linearity over the entire imaging exposure dynamic range	Review on-board calibrations provided by SI Analyze images over radiometric targets to obtain accuracy Validate prior to data purchase, every 2 months for first year, and every 4 months for the remainder of the data buy
Dynamic range (number of bits)	Perform general statistical analysis of data Review on-board calibrations provided by SI Validate prior to data purchase, every two months for the first year, and every 4 months for the remainder of the data buy
Absolute Horizontal Geometric Accuracy ± 250 m	Analyze images over ground control points to obtain accuracy Validate prior to data purchase, every 2 months for first year, and every 4 months for the remainder of the data buy

Table 2. System specifications addressed during product validation and corresponding validation tasks

SHIPMENT VERIFICATION – 100% INSPECTION

NASA sends all data products delivered under this contract through an automated ingest process and visually inspects JPEG (Joint Photographic Experts Group compression algorithm) browse image chips created from the actual data. This checks 100% of the products for discrepancies between requested and actual acquisition properties (date, location, processing level, cloud cover), packaging mistakes, and gross image quality errors. Inherent in the ingest process (Figure 3) is a test of the physical media that contains the data product. The process is automated except for the visual inspection, which is performed by a trained image reviewer using a web page display (Figure 4).

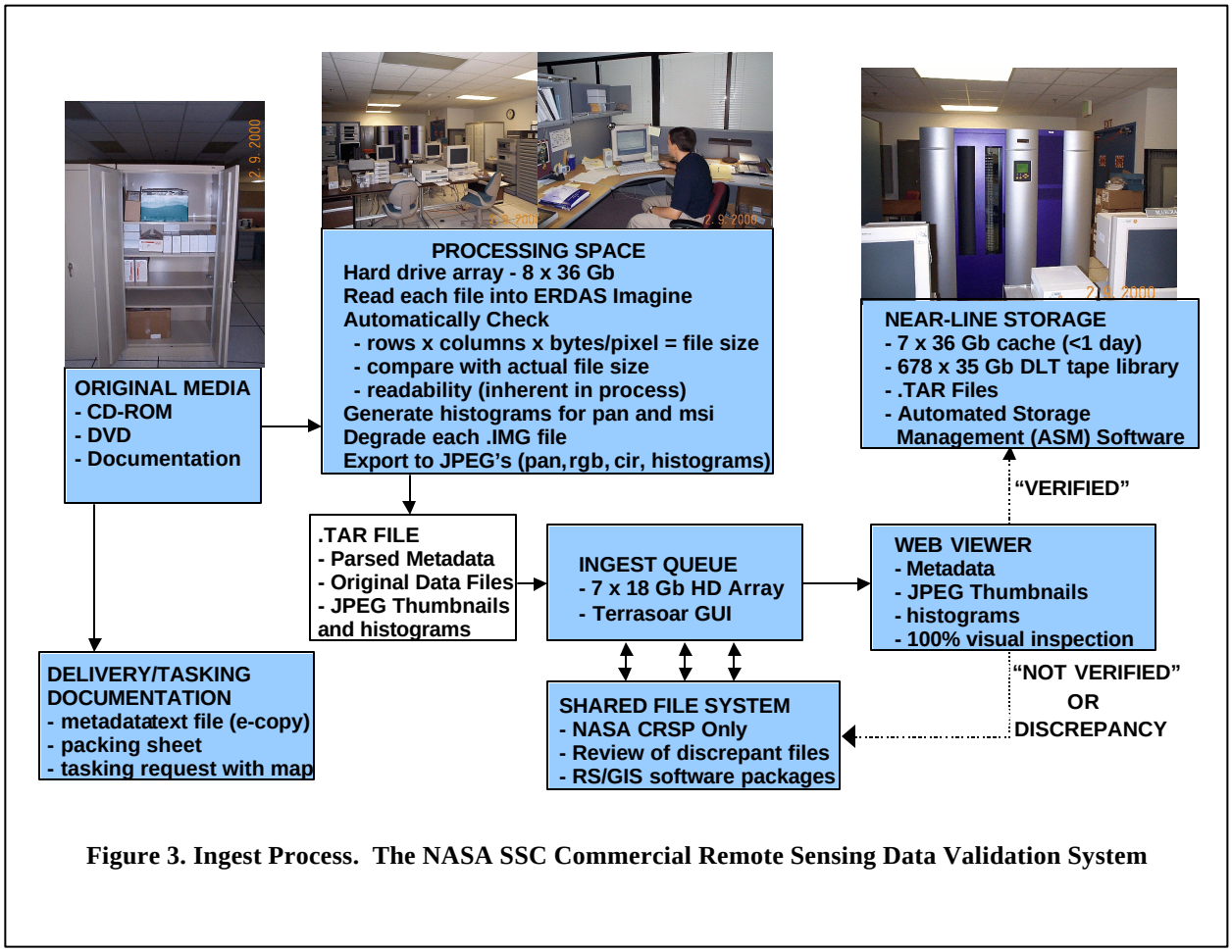

Figure 3. Ingest Process. The NASA SSC Commercial Remote Sensing Data Validation System

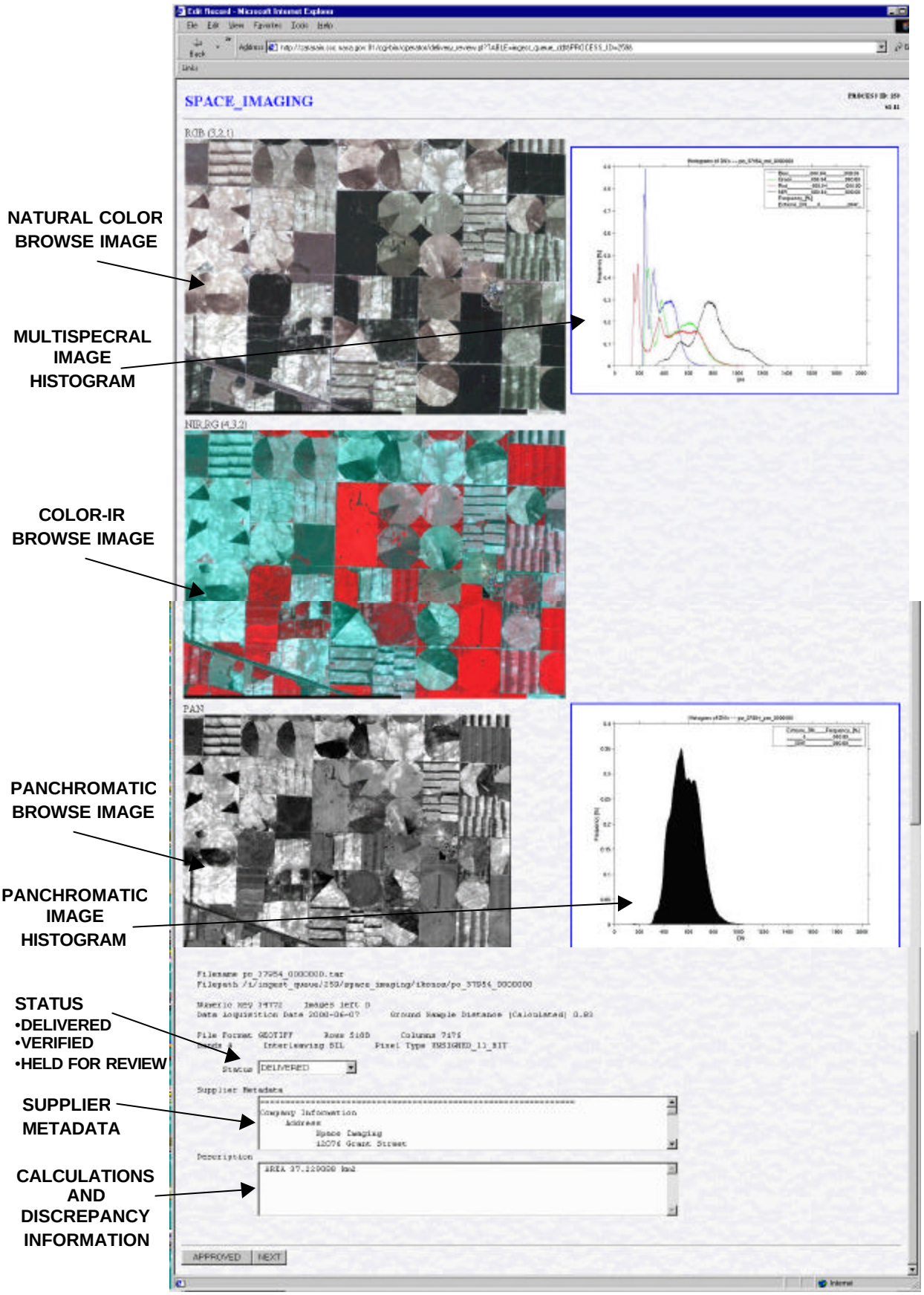

Figure 4. Shipment Verification Web Page for 100% Inspection. The band combinations selected for the JPEG browse images are the three most common combinations that scientists will use. The histograms indicate the amount of dynamic range actually used in each band—one measure of science utility.

SURVEILLANCE TEAM

- NASA Commercial Remote Sensing Program Office – ESE Science Data Purchase program management
- SSC Test and Technical Services Contractor (TTSC) Science Data Purchase Team – media count, file readability, product type verification, and product discrepancy resolution
- SSC Support Contractor – geographic coverage, acquisition date, image quality, and cloud cover
- TTSC Technology Validation Group – system calibration review, product validation, and coordination of image collections for product validation

DOCUMENTATION AND REPORTING

The NASA John C. Stennis Space Center ISO 9001 quality system controls the surveillance process for this contract. An independent ISO 9000 registrar audits the Science Data Purchase quality system and work processes every six months. Surveillance activities that are considered operational are documented in work instructions, and the results are recorded in electronic databases and validation reports. NASA screens surveillance documents and records for proprietary data, then makes them available to the end users of the data (scientists affiliated with NASA's Earth Science Enterprise). The TTSC Science Data Purchase Team tracks significant event dates, changes, and discrepancies for each shipment from original tasking request, through verification and validation, to receipt and evaluation by the end user. The Team also compiles monthly reports on these metrics and disseminates the reports within the Commercial Remote Sensing Program.

SUMMARY

This Surveillance Plan describes the approach Stennis Space Center intends to use to monitor the delivery of scientific data imagery from the IKONOS satellite and assure that the Contractor performs in accordance with terms and conditions of the Contract. Stennis Space Center anticipates using a hybrid-driven surveillance approach of insight and oversight. The goal is to balance the level of Government surveillance commensurate with programmatic risks.

Stennis Space Center plans to use a Surveillance Team to evaluate Contractor performance and direct surveillance activities. The Team will obtain data and provide information on Contractor activities. The Team will establish and rely on an established Verification and Validation Process and assess Contractor performance against this process.

As experience is gained with the Contractor, the Government reserves the right to change this Surveillance Plan and the process used to evaluate Contractor performance. However, in cases where a new surveillance process might affect fixed unit rates, changes may be negotiated with the Contractor.